X. DEALING WITH SHORTAGES AND WATER QUALITY PROBLEMS

The most effective responses to a potential water shortage depend heavily on prior resource planning and development. Most industries have facilities located where adequate supplies are known to exist and other risks appear acceptable. Cities have often built reservoirs, negotiated mutual aid arrangements with other water suppliers, or located other back-up supplies. Responses have generally related to improving "raw" water availability. Source-related problems brought on by a short-term drought would not be acceptable to most communities. Such droughts which readily produce inconveniences only seem to suggest that more serious problems lie ahead. On the other hand, infrequent source-related problems produced by an extended drought might constitute an acceptable risk most users are willing to assume (Keck, 1986).

Typically, short-term actions in response to drought involve development of a "phased" drought and emergency management plan. A drought management plan should sequence management responses to increasingly severe drought conditions and possibly de-activate phases as conditions improve. Local officials should plan public education, enforcement, monitoring procedures, conservation objectives, and other actions necessary to achieve plan goals. Three phases are recommended: "Conservation," "Restrictions," and "Emergency" (Keck, 1987). See Figure 4, "Drought Responses."

The responses in the various phases of this water management guide tend to be demand reduction oriented. Options involving supply augmentation are often economically unattractive. Consequently, most systems focus on water conservation, rather than on improving water supplies. This guide identifies those options, both supply and demand-side oriented, which are most appropriate in response to the three recommended phases. Some responses may not be appropriate for every system. After an appropriate analysis and selection of options, the resulting plan should balance the system's demand with its supply (Figure 2) at three different levels of water availability.

Recognizing that demand-side responses are possible no matter what the system's sources, this Guide suggests that responses specified in the "Conservation" phase reduce water use by 15 to 20 percent; that "Restrictions" phase responses reduce water use by 30 to 40 percent; and that "Emergency" phase responses target a reduction in use of 60 percent or more.

A. OPTIONS FOR DEALING WITH SHORTAGES

"Normal" Conditions

Under normal conditions utility district and municipal actions can promote water conservation, detect and repair system leaks, and replace inefficient water using equipment. Actions may involve developing a city reservoir, construction of storage tanks, expanding treatment plant capacity, and establishing mutual aid agreements with neighboring water suppliers. Another long-term action is adoption of a plumbing code encouraging water saving fixtures (Keck, 1987).

Although some remedies appear to be spontaneous responses, emergency water supply management plans and adoption of ordinances.to implement plans in times of drought or emergency should be pursued in advance. These activities include making an equipment inventory, identifying potential water haulers, suppliers of equipment, preparing educational and media materials, and developing contingency contracts with bottled water suppliers. Preparation for drought will be more desirable and effective than remedies enacted in haste (Keck, 1987).

Long-term objectives affect the responses considered and planned over the short-term. Physical and capital improvements were briefly discussed in the section of Chapter IV, "Goals and Objectives," dealing with the criteria used to evaluate supply dependability. This Guide will not attempt to describe those options in any further detail. Following this section are options of water conservation education, pricing, metering, pressure reduction, reservoir evaporation suppression, detection and repair of system leaks, water reuse, and water saving plumbing codes.

Water Conservation

Water conservation reduces water use. Reduced per capita water use is especially helpful in deferring the need for new or expanded water treatment facilities, and in effect reduces per capita cost of providing water. Water conservation, however, does not eliminate the need for a drought management plan especially where the system continues to rely on a source having a shortage-related risk. Systems also need to develop plans which address the system's ability to maintain supplies to those already practicing conservation and having few opportunities for reducing demand.

When water conservation is not pursued under normal conditions, it can be an effective response to a temporary water shortage or emergency. When conservation is practiced routinely, water may be difficult to conserve beyond what has already been accomplished (Matthai, 1979).

In addition it should be noted that water users who conserve water should also be informed of the potential health-related concerns resulting from use of "first-draw" water from taps. That is, turning on the tap and using water immediately without running it for a minute or so to flush out the water which has been standing in water lines for an extended period of time. This concern applies particularly to homes constructed within the last five years using copper plumbing with lead/tin solder. Because the lead can be leached out, and protective deposits in lines are not yet in place, water users should be encouraged to run the water line enough to flush out water lines prior to any water use for drinking or cooking purposes.

Water Conservation Education. The objective of a conservation program is to reduce the quantity of water required for each activity through more efficient water use practices. These practices may apply to the residential, industrial, commercial, agricultural, recreational, and public sectors.

Appendix B, "Obtainable or Adaptable Water Conservation Education Materials," contains a list of brochures, fact sheets, pamphlets, and other materials available to the public, promoting conservation measures. These brochures and pamphlets are often inexpensive and can be purchased by a water supplier to mail to customers. Or a supplier may develop its own materials. More recent health-related concerns resulting from water conservation may need to be addressed at the same time. Users who want to conserve water but are concerned about higher concentrations of lead and other contaminants should beinstructed to fill drinking water containers for ther refrigerator, etc., after lines have been flushed out through other uses. The effectiveness of a conservation education program may depend on overcoming this and similar user concerns.

Figure 16, "Opportunities to Reduce Water Use," shows a hypothetical system's breakdown of water use into sectors. In this scenario, single family water use predominates over multi-family, commercial, and institutional uses.

Figure 16

Opportunities to Reduce Water Use (East Bay Municipal Utility District, 1985)

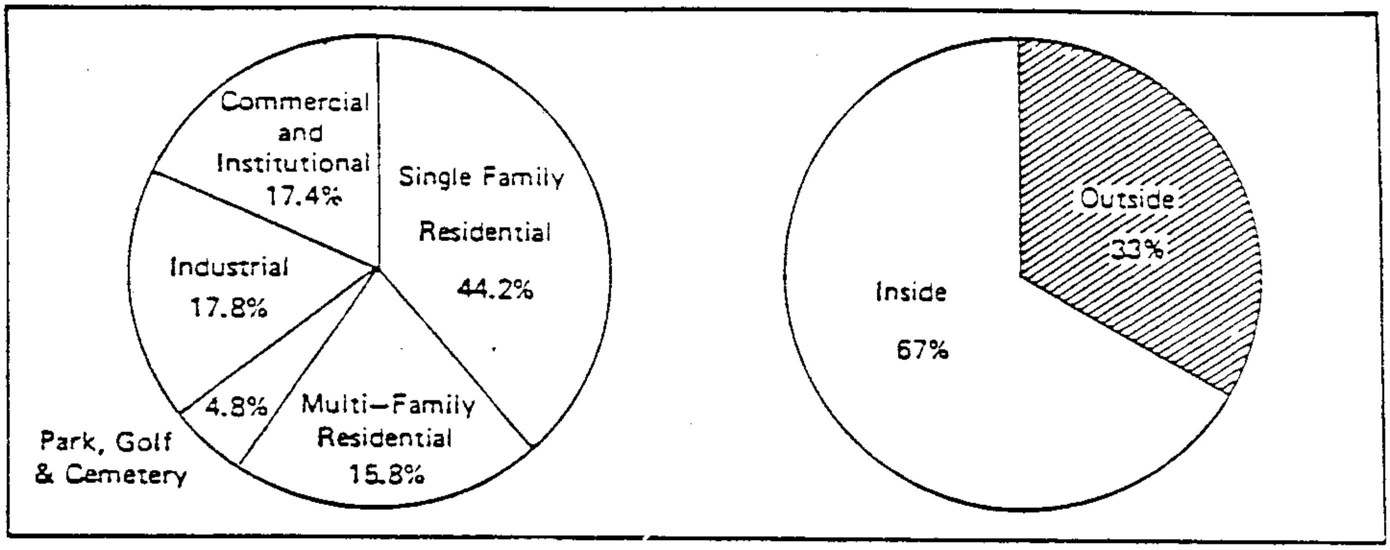
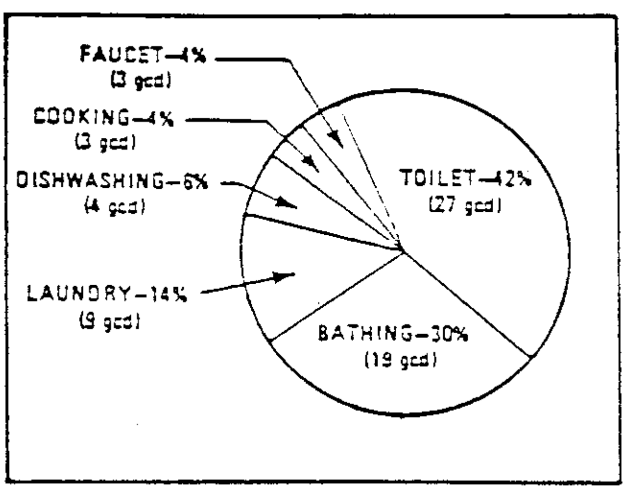


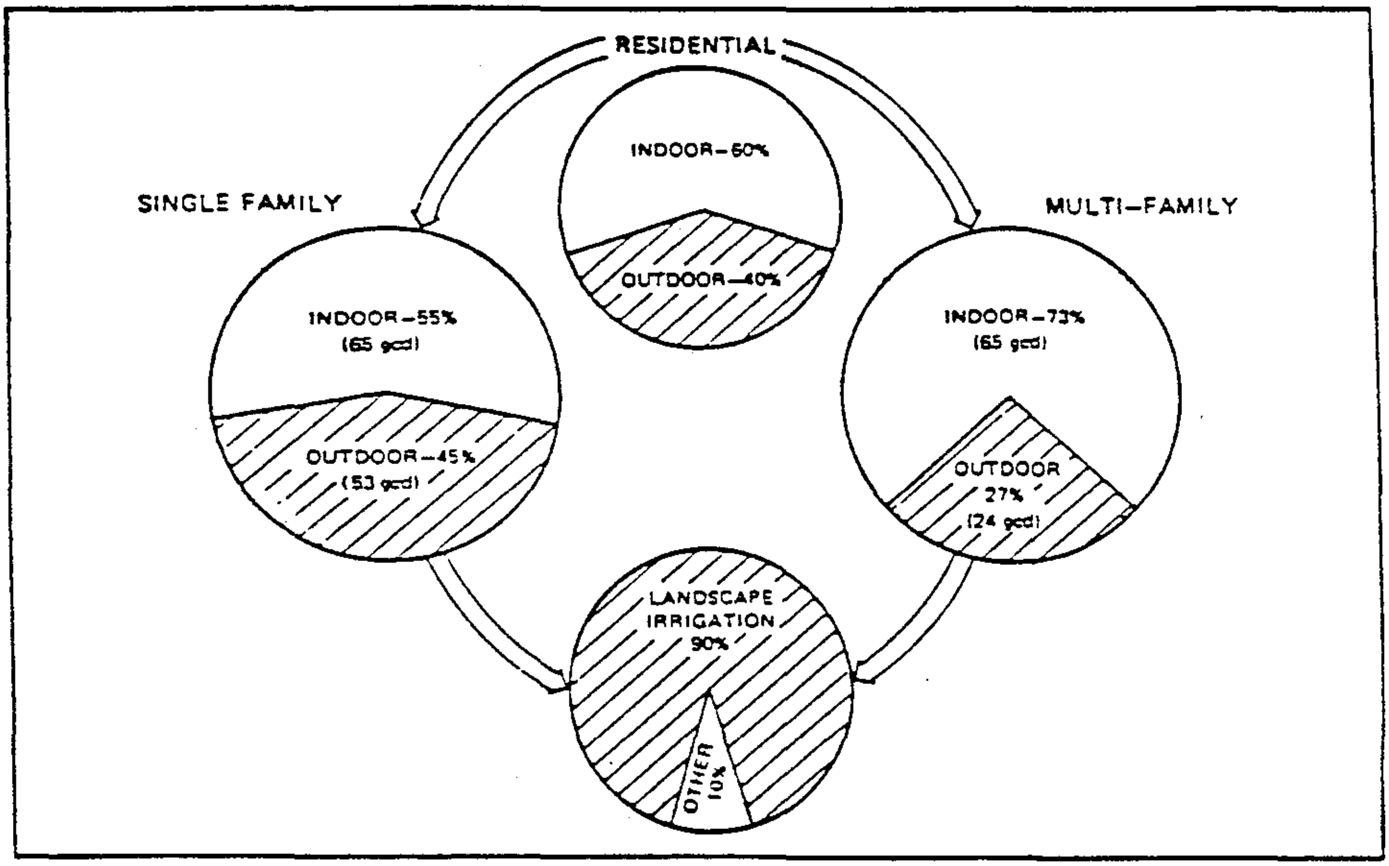
Figure 17, "Single and Multi-family Residential Indoor Water Use," shows a breakdown of multi-family and single-family indoor water use which averages 65 gallons per capita per day (gpcd) for this hypothetical system. Clearly a water conservation education program aimed at reducing water used to flush toilets and bathing is needed. Another conservation opportunity, as shown in Figure 18, "Single and Multi-Family Residental Water Use," is to reduce the amount of water used in landscape irrigation. A water supplier may also wish to conduct home or office water audits and recommend practices to improve water use efficiency.

Figure 17
Single and Multi-Family Residential
Indoor Water Use (East Bay Municipal Utility District, 1985)



Depending on the specific measures used, the potential water savings in toilet and bathing could approach 40 percent of an average family's use. For instance, significant reductions in water use can be realized if shower times are shortened. If consumers can be persuaded to reduce shower times by 25 percent, a savings of 5 gallons per person per day would result. An even more effective measure is turning the shower on to allow an initial soaking, turning it off for lathering and washing, and then turning it back on again for rinsing. Water conservation education used in connection with other water conservation measures such as leak detection, pressure reduction, etc., might exceed 50 percent of some system's water use (Smith and Lampe, 1982).

Figure 18
Single and Multi-Family Residental Water Use
(East Bay Municipal Utility District, 1985)



Many commercial and industrial establishments use large volumes of water and can give considerable assistance to conservation programs by reducing their water use. Examples of the types of commercial and industrial establishments which use large quantities of water from public supplies are car washes, ready-mix concrete plants, greenhouses and nurseries, meat-packing plants, laundries, food processing plants, and certain chemical or petroleum processing facilities. Many of these establishments can achieve considerable reductions in water use merely by instituting a program to conscientiously monitor and reduce water use to the minimum amount consistent with the requirements for producing their product or service.

Reductions may be possible where water is used for spraying or rinsing products and general plant cleanup. In some cases, increased treatment of water by the industry may allow them to reduce water use. For example, cooling water may be cycled through cooling towers more times if the water is softened or if certain corrosion and scale inhibitors are added to the water.

Since the water-use patterns of each industry are different and significant differences can occur even between similar plants in the same industry, water conservation can be accomplished only by consulting with the management of each industry and cooperatively developing a water conservation program suitable for their operation (Smith and Lampe, 1982).

Water Saving Devices. Closely related to changing water use habits is the installation of water saving devices. Voluntary programs encouraging these "retrofit devices" are a major component of many conservation education programs. A brochure is provided in Appendix B, "Obtainable or Adaptable Water Conservation Education Materials," showing many of these devices.

Water suppliers can make information available on these devices to plumbers and customers to use when they purchase or install plumbing fixtures, lawn watering equipment, or water using appliances. Information regarding pipe insulation and retrofit devices such as low-flow shower heads or toilet dams that reduce water use by replacing or modifying existing fixtures or appliances should be a part of this program. A water supplier may also promote conservation by providing certain devices (toilet dams, insulation of hot water pipes, low flow showerheads, flow restrictors, etc.) free or at a reduced cost to the customer. Plumbing codes may make these devices mandatory in some areas.

Repair of Household Leaks. Many residences have small leaks in the plumbing systems, particularly at faucets and toilets. Customers should be encouraged to repair all leaking faucets and toilets. Leaky faucets can usually be repaired by replacing the worn washer or O-ring in the faucet valve with a new one. Leakage from toilets is usually caused by a worn ballcock valve or faulty flapper. It can be detected by the sound of flowing water or by the use of leak detection tablets or food coloring placed in the water in the tank of the toilet. Fifteen to 20 percent of the toilets in service are likely to be leaking at any given time (Smith and Lampe, 1982).

Pricing. Pricing may be the most effective means to reduce residential peak use and commercial/industrial use. In addition, a pricing program may also provide extra revenues even as water use decreases. Sometimes, however, revenues decrease to the system as a result of user conservation.

Pricing or rate structures can be permanently employed by a public supplier to encourage water conservaton over the long-term or stand-by rate structures can be developed and implemented when the system is confronted by a water shortage. The major obstacle to a long-term pricing program is user opposition.

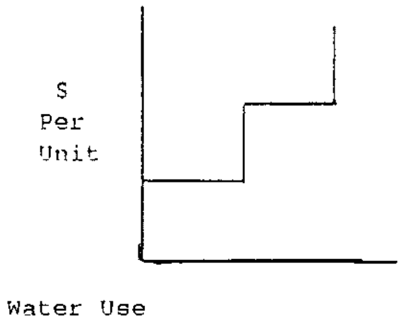
Local governments encourage low rates to attract industry. Estimating reductions in water use from pricing changes is complicated for two reasons: water is a basic necessity of life and, therefore, a minimum usage is necessary; and the price of water is normally so low that many consumers do not consider the economics of water supply. Nevertheless, various pricing schemes have been employed in attempts to decrease water usage for periods of time. Traditional water pricing methods have included:

- a set fee, which disregards volume used; or
- declining block rates where the pre-unit cost decreases as volume increases.

The rationale for declining block rates is that the per-unit cost of serving large water users is less than that for small water users. Declining block rates can be an incentive to waste water (New York State Senate Research Service, 1986).

The most common strategies are listed in Figure 19, "Common Price Structures." Adopting a particular price structure may depend on the number and influence of large-volume water uses served.

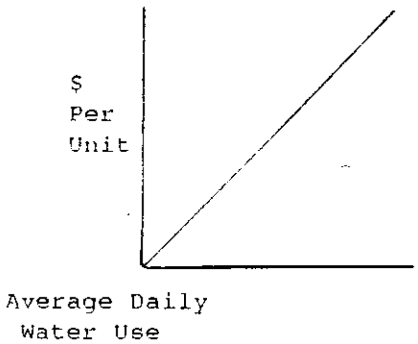
Figure 19
Common Price Structures (New England River Basin Commissioner, 1980)



Structure: Increasing block
Price per block increases as water use increases.

Best Used For: Reducing average (and sometimes peak) use.

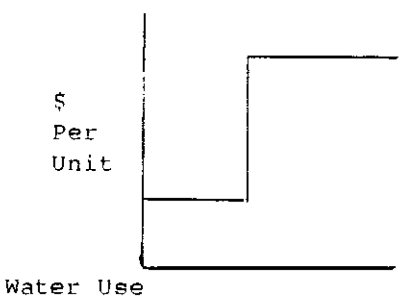
Considerations: Large volume users consider inequitable.



Structure: Sliding scale
Price level per unit for all water used increases based on average daily water use.

Best Used For: Reducing average (and sometimes peak) use.

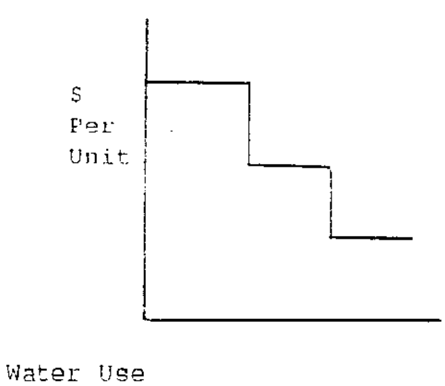
Considerations: Large volume users consider inequitable.



Structure: Lifeline Rate
Price for "necessary" water use is kept low.

Best Used For: Reducing average use.

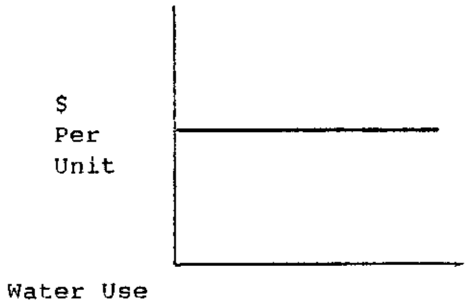
Considerations: Usually used to insure that low income users are not unduly burdened by high prices.



Structure: Decreasing block rate
Price per unit decreases as water use increases.

Best Used For: Reducing either peak or average use.

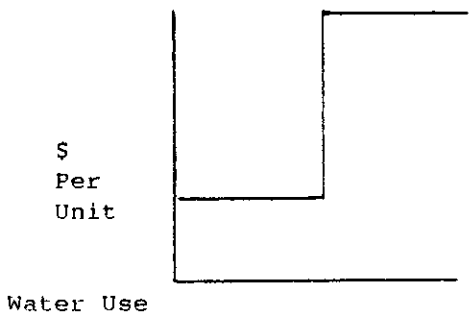
Considerations: Large volume users perfer this structure.
When there is sufficient supply, costs of supplying water will probably decrease as water use increases.



Structure: Uniform rate
Price per unit is constant as water use increases.

Best Used For: May be somewhat effective in reducing **use.**

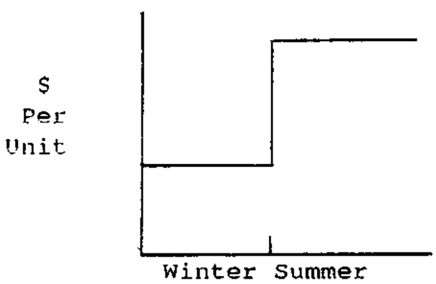
Considerations: Large volume users consider this structure equitable.



Structure: Excess use or Surcharge
Price level is significantly higher for all water used above average, usually determined by winter use.

Best Used For: Reducing peak volume.

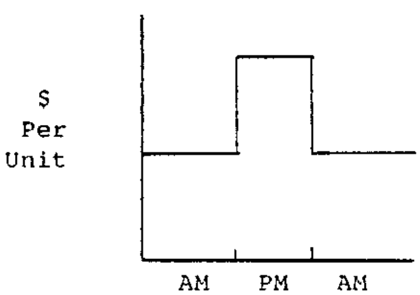
Considerations: Large volume users consider equitable.



Structure: Seasonally Adjusted Rate
Price level during season at peak use (summer) is higher than level during winter.

Best Used For: Reducing peak use.

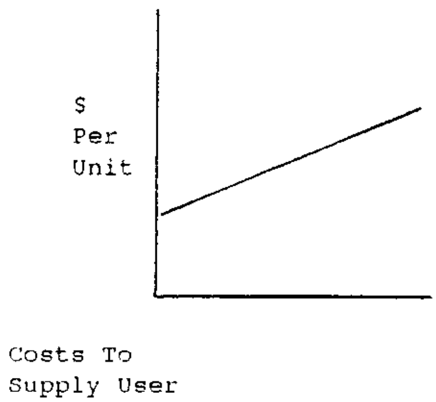
Considerations: Large volume users consider equitable.
Effective for summer tourist community.



Structure: Daily peak load
Price level is higher during hours of peak use.

Best Used For: Reducing peak use.

Considerations: Expensive to implement since sophisticated meter reading system would be necessary.



Structure: Spatial pricing
User pays for actual costs of supplying water to his establishment.

Best Used For: Discouraging new or difficult to serve connections.

Considerations: Used in areas where distribution system is being expanded rapidly and being expanded in difficult to serve areas (long mains, pumps, etc.).

It is difficult to determine the many different impacts pricing may bring on, or how much water can be saved by implementing a specific pricing strategy. Reduced water usage can not only effect revenues, but also sewer treatment needs if rate structures are permanent. Virginia Beach, Virginia, for example, went from a decreasing block rate structure to a uniform rate structure, reducing its water use; and Dallas, Texas reduced its summer usage of water by nearly 12 percent when it instituted a seasonably Adjusted Rate Structure (Reed, 1982).

Universal Metering. Some water suppliers do not meter all water use. Metering helps the conservation of water and insures equity in customer charges for water. Metering makes water use accounting and leak detection easier. Metering provides consumers with feedback on their water use and makes consumers more aware of water as a commodity.

A problem encountered by systems submitting to metering is that reductions in water usage frequently decrease revenue. An advantage is that long-term capital expenses can be reduced. Frequent reading of meters can also facilitate conservation efforts. Technology exists for meters to be remotely read by computers through telephone line connections quickly and efficiently, once the equipment is in place (New York State Senate Research Service, 1986).

Pressure Adjustment. One measure used to improve supplies or reduce use is to adjust pressures in an entire water system, in part of a system, or in individual services. "Decreasing water pressure diminishes the amount of water flowing through open faucets. While 50 pounds per square inch (PSI) is considered sufficient for residential use, pressures exceeding 80 PSI are common." Under emergency conditions, reductions to 20 PSI may be acceptable. Recommended pressure is 60 PSI (New York State Senate Research Service, 1986).

In other instances, areas served by a public water supply need additional pumping capacity at booster stations, etc. Improvements in the distribution system may correct water shortages within some systems.

"Water pressure also has an effect on system leakage. High pressure is one cause of pipe joint leaks and it generally causes water facilities to wear out more rapidly. High pressure also produces greater losses through existing leaks: A pressure of 100 PSI, for instance, will discharge approximately 40 percent more water from a leak or outlet than will a pressure of 50 PSI" (New York State Senate Research Service, 1986).

"Household pressure-reducing valves are cost-effective where system pressures exceed 60 PSI, and savings can be achieved with little or no customer inconvenience. Peak water use reductions can be particularly significant" (New York State Senate Research Service, 1986).

"Consumers are likely to accept pressure reductions as long as sufficient pressure remains for household purposes and personal comfort. Household flow restrictor valves attach at the water meter to reduce pressure throughout the house. The fixtures are probably too expensive to warrant free distribution, but household savings can justify consumer purchase in high-pressure areas. System pressure reductions necessarily are the responsibility of the water supplier. Because many water systems have various pressure zones, system pressure reductions require close monitoring." Pressure reduction by many systems has produced reductions in use from 5 to 30 percent, depending on previous pressure levels (New England River Basin Commission, 1982).

Leak Detection.

"Substantial savings can be obtained by locating and repairing leaky pipes and pipe fittings in water systems and within buildings. Many water supply systems repair leaky and broken pipes only when a problem becomes obvious--water flows out to the ground surface, the pavement collapses or an area suffers a severe loss of water pressure. Available techniques, however, enable trained operators to detect underground leaks before they cause obvious damage or disrupt service" (New York State Senate Research Service, 1986).

The costs of detection will of course vary from system to system, depending on the detection techniques used. If large amounts of water are being lost due to leakage, a scan of the system using a listening technique might be appropriate. The most widely used equipment includes the aquaphone, the geophone, and electrosonic instruments. In some instances a water audit or a detailed survey of the distribution system may need to be conducted.

Estimates developed by the Pittsburgh Equitable Meter Company indicate that at 60 pounds of pressure, 400,000 gallons of water will be lost through a 1/4-inch hole in one month, 100,000 gallons through a 1/8-inch hole, and over 6,000 gallons through a 1/32-inch hole (Wentz and others, 1986). Although, some leaks may be so small that it is uneconomical to repair them, water saved through a leak detection program can result in considerable savings. Unaccounted-for water (leaked water, plus water used for municipal use and fire fighting, plus water unaccounted for by underregistering meters or other unmetered uses) may vary from 10 to 15 percent in a well-operated system (New York State Senate Research Service, 1986).

In almost all systems, most of the unaccounted-for water is lost through leaks. Average water system leakage in the United States is estimated at 12 percent, but leakage is known to exceed 40 or 50 percent in some systems. Even efficient systems can gain from leak detection, with obvious benefits to systems with over 15 percent leakage (New York State Senate Research Service, 1986).

"Leak detection should be a regular activity of every water supply system. Periodic checks should be made on valves, hydrants, and services to locate obvious underground leaks. The first step in a leak detection program is a leakage survey. The survey involves (New York State Senate Research Service, 1986):

- examining water distribution system records to locate mains, valves and hydrants and determine pipe sizes (good record-keeping is an essential part of leakage surveys);
- checking conditions of valves and hydrants;
- inspecting storm drainage systems during dry weather for evidence of leaks;
- dividing distribution systems into test districts;
- plotting the locations of all water users;
- investigating nighttime use of large water users;
- calculating predicted nighttime use for each zone; and
- determining realistic figures for acceptable leakage in each zone.

A leak detection program can be a valuable conservation program in reducing water loss during a water shortage. Nevertheless, the cost of a leak detection survey should be compared to the potential benefits of the water saved.

Reservoir Evaporation Suppression.

The only way to suppress reservoir evaporation is to cover an open storage reservoir. It should be considered if losses due to evaporation are 10 percent or more or a system's total supply. It may not be a cost effective means to reduce losses, unless it is done to protect water quality also.

Water Saving Plumbing Codes.

Local governments may adopt ordinances or plumbing codes that require the installation of water conserving devices in all new construction. At present, Tennessee codes do not require low flow fixtures or water conserving devices. A local water conservation example ordinance is included in Appendix C, "DuPage County Plumbing Code Amendment."

Where a local code requiring water conservation is not adopted, a water supplier can elect to distribute information to their customers to encourage them to purchase and install water saving plumbing devices. These devices include pressure reducing valves, faucet aerators, water saving toilets, flow limiting faucets and showerheads, and insulated hot water lines. New swimming pools should have recirculating filtration equipment as part of the system. The standards for residential and commercial fixtures should be:

Tank-type toilets	-	No more than 3.5 gallons per flush
Flush valve toilets	-	No more than 3.0 gallons per flush
Tank-type urinals	-	No more than 3.0 gallons per flush
Flush valve urinals	-	No more than 1.5 gallons per flush
Shower heads	-	No more than 3.0 gallons per minute
Lavatory and kitchen faucets	-	No more than 3.0 gallons per minute
All hot water lines	-	Insulated
Swimming pools	-	New pools must have recirculating filtration equipment

"These standards are recommended because they represent readily available products and technology and do not involve additional costs when compared to standard fixtures (Texas Water Development Board, 1986)."

Analysis has shown that the use of water saving devices presently available from manufacturers could reduce residential use from 15 to 35 percent. Current technology coupled with conservation practices could produce a 30 percent reduction in total water demand (Reed, 1982). Jurisdictions that have adopted water conservation standards have had few problems in enforcing the codes where adequate advance notice of code revisions were given to plumbing suppliers and contractors (Georgia Department of Natural Resources, 1983).

Reuse.

Water reuse is not a popular measure due to its higher costs and user reluctance to reuse water for potable purposes. Nevertheless, in some cases it should be considered for some non-potable purposes. For home purposes, it may be reasonable to design plumbing which utilizes "grey water" (sink and shower wastewater) for toilet flushing.

Reuse is good where the use of treated effluent can replace an existing use that currently requires fresh water from a public supplier. Recycled water may be useful for landscaping or irrigation use by some industries. Problems occur primarily on water quality/health-related issues (New York State Senate Research Service, 1986).

Under "Alert" Conditions

Under "Drought Alert" conditions, water suppliers should intensify their monitoring for potential conflicts or problems. Potential conflicts and problems are those situations which have appeared under previous water shortage conditions or have the potential for occurring.

Under "Conservation" Conditions

During a drought, municipalities and utility districts can experience both raw water supply and treatment facility problems. Water use curtailment can alleviate both types of problems. **Most of the measures applicable under "Normal" conditions are effective in reducing water use under "Conservation" conditions.** Municipalities and utility districts can activate conservation water pricing structures which encourage reduced use. Municipalities and utility districts could institute public education programs aimed at reducing water use. Conservation brochures, radio and TV announcements, newspaper releases, and public meetings could inform customers on ways to save water in domestic, landscaping and recreational uses. Municipalities and utility districts could distribute (at public meetings) and/or install toilet tank displacement devices, shower flow restrictors, and replace leaking faucet washers and flappers in commodes in a door-to-door program (Keck, 1986).

Indoor measures considered under a "Conservation" phase should include flushing the toilet fewer times, shorter showers and shallower baths, using washing machines and dishwashers only with full loads or washing by hand, turning the shower off while soaping or shampooing and keeping a bottle of drinking water in the refrigerator (Keck, 1987).

Non-essential outside uses of water could be banned under a "Conservation" phase. Outside uses of water may account for as much as half to two-thirds of total residential water use in the summer. The outside uses of water that are generally restricted include watering lawns, gardens, trees and shrubs, filling swimming pools, and washing cars. Since water shortages are usually most severe during the hot, dry days of summer when outside uses of water are greatest, restrictions on outside water uses are often effective in reducing total water use (Smith and Lampe, 1982).

The advantage of restrictions on outside uses is that total water use can be decreased significantly. Enforcement of the restriction is relatively easy since violations are usually apparent to utility officials, police, or other residents. Disadvantages are that the appearance of lawns, flowers, and shrubbery in a community will decline, unfilled swimming pools will be unused, and vehicles will remain unwashed (Smith and Lampe, 1982).

It is particularly important to enforce bans on all public uses of water, such as watering parks and golf courses and street-washing. An exception to this ban might be filling a municipal swimming pool. Three types of restrictions on outside use are commonly employed: time-of-day restrictions, alternate day restrictions, or a complete ban (Smith and Lampe, 1982).

Time-of-day restrictions allow outside uses of water only during specified hours of the day. Outside uses are usually forbidden during the portion of the day that is the hottest and during which water losses from evaporation will be the greatest. Also, by reducing the number of hours in the day that customers can use water outside their houses, it becomes less convenient to use the water (Smith and Lampe, 1982).

"Since time-of-day restrictions are imposed during peak use periods of the day, the stress on distribution facilities is reduced." The effectiveness of time-of-day restrictions in reducing water use depends largely on the times of day for which outside uses are prohibited and the enforcement of the restrictions. Time-of-day restrictions should restrict outside uses between 8:00 a.m. and 6:00 p.m. in the evening (Smith and Lampe, 1982).

"Another option is to allow outside water use only on alternate days or every third day. To equalize the load on treatment and distribution facilities, residential service areas are divided into two or three equally sized groups and each group of customers is allowed to use water for outside uses on specified days." The use of house numbers is a popular method for dividing customers into groups, but other methods may work as well. Other methods include dividing the service area into sections or using different sides of streets to indicate when outside uses were permitted or prohibited (Smith and Lampe, 1982).

Advantages of time-of-day or alternate day restrictions are that water use can be reduced while customers are still given an opportunity to continue outside uses on which they place high priorities. A disadvantage is that, depending on the schedule selected for restrictions, water use reductions may not be more than five to ten percent of total water use. Enforcement of the program is often difficult due to confusion concerning the hours or days when certain customers are allowed to use water (Smith and Lampe, 1982).

Because outside water uses often make up a significant percentage of total residential water use, a complete ban on non-essential uses can reduce total water use considerably. "The amount of water saved will be much higher in the summer than in the winter. Reductions in water use achieved through complete bans on non-essential outside uses can approach fifty percent of total water use during the summer for some systems." A complete ban on non-essential outside uses is equitable by residents since no group is favored over another (Smith and Lampe, 1982).

Once a "Conservation" phase is activated, conservation actions (in addition to those pursued under normal conditions) must be implemented by water users if goals are to be reached. If a water supplier has had an active water conservation program to reduce overall water use under normal conditions, additional measures or restrictions will need to be implemented.

In some instances, many existing measures may remain as voluntary while other uses are cut back or even banned. The water supplier's classification scheme like the one shown in Figure 15, "Recommended Water Use Classes and Class Restrictions," should serve as a guide in designing a conservation program.

The imposition of restrictions and/or bans must be practical for enforcement. In other words, restrictions should be imposed which are enforceable. Where lawn watering bans are required, the supplier should have a plan for enforcing the ban. The activation of a "Conservation" phase should enable a water supplier to meet its pre-established objectives.

Where objectives are not met, the water supply system must consider implementation of the next most restrictive phase. This was the situation in the case of Virginia Beach, Virginia, in response to the 1980-81 drought. Requests for voluntary reductions in the consumption of water and a ban on non-essential uses did not significantly reduce the city's total daily consumption of water. However, the establishment of a water-allotment (rationing) program with surcharges based on a maximum-use allowance was quite effective in reducing water use.

A water conservation plan, if not carefully designed, can actually increase use. Many people may overwater, sprinkling the lawn whether or not it needs it. Research by the Virginia Water Resources Research Center revealed that the success of a conservation program depends on (1) the public perception of the program's fairness and (2) a thorough public information and education program to inform water users of the drought's seriousness and delineation of water-saving practices (Alexander and others, 1984).

Under "Restrictions" Conditions

The effectiveness of a "Restrictions" phase also depends on the public's perception of crisis. If imposed too frequently over extended periods of time, regulators risk losing credibility.

<u>Conservation Measures</u> (including rationing, bans and shut-offs).

<u>**Response options under "Restrictions" conditions include mandatory conservation rather than voluntary.**</u> Figure 15, "Recommended Water Use Classes and Class Restrictions," should serve as a guide in designing a "Restrictions" phase. Under a "Restrictions" phase, municipalities and utility districts could mandate reductions on a weekly basis to consumers.

A "Restrictions" phase could begin when projected water use exceeds the anticipated thirty-day supply, system hydraulic problems are encountered, or the system's "Conservation" phase goal of a given percent reduction (for example 20 percent) is not being met (Keck, 1987). Mandated conservation could be tied to a percentage reduction in use based on the previous year's usage for the same period (often referred to as the "base-period").

In addition, all outdoor water uses might be banned, or perhaps watering of lawns might be prohibited, but allowing the hand-held application of water to shrubs. Utility districts and municipalities could also restrict the time of operations for some industries or require percentage cut-backs from previously established levels of use. Restaurants, hospitals and nursing homes might be required to use disposable paper cups and plates in food service and to serve water only on request. Enforcement of conservation might be based on service shut-offs and penalties for non-compliance (Keck, 1987).

Rationing.

Rationing measures can be formulated with the objective of producing a specific reduction in water use. Because the percentage reduction in water use attributable to various types of restrictions on outside uses are generally not well defined, a percentage reduction based on a seasonal increase in use might be considered. During the summer, when the water usage for lawn and garden watering is great, systems might expect restrictions on outside uses to result in a significant percentage reduction in use. "If outside uses are completely banned, this reduction may be as great as fifty percent, but is more likely to be about thirty percent. Partial restrictions on outside uses, as with time-of-day or alternate day restrictions, result in lesser reductions in water use than the complete bans on outside uses" (Smith and Lampe, 1982).

The effectiveness of rationing will largely depend on how strictly the measure is enforced and the severity of penalties imposed on violators. For water rationing plans to be effective, the user must suffer a severe penalty for excess water use or plan non-compliance. "It is advisable from a public relations standpoint to use escalating penalties for noncompliance, rather than an across-the-board severe penalty" (Smith and Lampe, 1982). After two violations customers could have service cut-off for five-days.

For example, the first violation of the rationing plan by a customer would result in issuance of a written warning to the customer. The second violation would result in assessment of a small fine, such as $100.00. The response to the third violation would be either a more severe fine, such as $200.00, or installation of a flow restriction device in the customer's service line. "The fourth violation would then lead to discontinuation of service to the customer." The management of each utility must decide which penalties are best their situation (Smith and Lampe, 1982).

A second form of rationing is the allocation of water to customers as a constant percentage of their normal use. Normal use is based on average use per billing period or use in the same billing period the previous year. This rationing plan can be used if the percentage of the normal water supply available for the foreseeable future can be determined (Smith and Lampe, 1982).

"The principal advantage of a rationing plan based on percentage of normal use is that all customers have to restrict their water use to the same degree, and those customers that have established higher water use requirements than other customers can still maintain their proportionately higher water use. This same aspect of the plan also serves as its primary disadvantage, since those customers who have previously wasted large amounts of water are allowed to use more water than other water users, thereby rewarding those customers who have habitually used water inefficiently" (Smith and Lampe, 1982).

Finally, a third form of rationing involves allocation of available water on an equal basis to each connection. This scheme is easily administered and is generally perceived as equitable, since each customer is allowed the same amount of water to use. However, it does not account for differences in water needs between different customers, particularly due to differences in family sizes (Smith and Lampe, 1982).

"A modification of this plan that somewhat overcomes the obstacle of varying water needs for different family sizes is the rationing of water on a per capita basis. With this type of rationing, water is allocated to residential customers on the basis of the number of occupants of a household" (generally 50 gallons per person per day). "However, this latter method is difficult to administer because determination of the actual number of occupants in a given residence is often uncertain." One way it can be done is to once a year, have customers indicate on their bill payment the number of occupants living at that address (Smith and Lampe, 1982).

Service Interruptions.

Water service interruption agreements with large water users should be considered by public suppliers. Special water rates established by a supplier for industries and other users may contain conditions in their contracts to shut-off or reduce water use during specified periods. When necessary, the system can valve off tanks and/or lines to extend supplies.

Mutual Aid Agreements.

In addition to imposing mandatory conservation measures or rationing, a system may also consider a variety of other measures to increase the system's available water supplies.

Establishing a mutual aid agreement is one of the best means of insuring the adequacy of water supplies during an extended drought. An interconnection with another utility, either for treated or untreated water can be made with nearby systems. Mutual aid may also include loaning of pumps, portable treatment plants, and other available equipment. Mutual aid, like other actions, is best executed when agreements, inventories, and contacts are made and periodically reviewed prior to a water shortage or emergency.

In planning for interconnections, the primary factors to be considered are the distance between the systems, the amount of water that would have to be transferred, the price paid for water and sharing costs for the water line connecting the systems. It is better to have the line in place prior to the drought than to attempt construction when the need is greatest (Smith and Lampe, 1982).

"The first step in developing an interconnection is to identify a nearby utility with water supply capabilities that are in excess of its own needs. The utility must then be contacted to determine whether an agreement can be reached . . . ." A formal contract should be negotiated that specifies how much water each utility can use and the price that must be paid for the water and under what conditions. Systems agreeing to assist adjacent systems must evaluate each other's vulnerability because they are committing themselves to sharing their resources. The utility having the greater potential need for will probably have to pay for construction of the interconnection line and any additional pumping facilities (Smith and Lampe, 1982).

"If possible, the interconnection should be built prior to the onset of drought, but, if necessary, it can be built when the need arises. However, design and construction of the line will probably take several months" (Smith and Lampe, 1982).

Temporary Pipelines and Sources.

If another source of water is reasonably close, and the public supplier has an agreement or rights to obtain water, "it may be possible to run a temporary pipeline to the treatment plant or the distribution system." Ideally, an auxiliary source would be a developed system with treated water, such as a nearby municipality, an unused groundwater source or an industrial supply with surplus potable water. It might also be a surface supply such as a quarry, lake, pond, river, or even a creek. While a surface water supply can be "discharged readily into an existing reservoir for untreated water, it is not readily adaptable to a system utilizing a ground water source" (Alexander and others, 1984).

In situations where surface water and groundwater supplies are to be used conjunctively and mixed together, the potential exists for some water quality-related problems to occur. Essentially, these problems manifest themselves through the (1) release of scaly deposits in the system's water distribution lines and (2) discoloration of the water delivered to users. Because of difference in pH between conjunctively used surface water and groundwater supplies, previous deposits in water distribution lines are frequently released resulting in stained laundry and residue in wash basins.

Also some existing groundwater supplies contain ferrous oxide. When this water enters the water system and is exposed to air, carbon dioxide is released and ferrous iron is changed to ferric iron, which then precipitates out of solution causing the water to become reddish in color.

In extreme situations of treatment plant failure or where a system normally uses a ground water source, untreated water may be introduced into a system, however untreated water cannot be used for human consumption. Nor can untreated water of unsuitable quality be used for any body contact purposes. Systems supplying untreated water must issue a "Boil Water Notice" and only after all water is treated and distribution lines disinfected can the "Boil Water Notice" be discontinued. Systems supplying untreated water may also need to haul water or provide bottled drinking water to their customers.

All sources and modifications to a system must be approved by the Office of Water Management, Division of Water Supply prior to their use as established under the Tennessee Safe Drinking Water Act.

Additional Wells and Reactivation of Abandoned Wells.

Drilling additional wells may not be feasible if the well field has not been investigated and water rights obtained. In addition, a well field may not be a suitable location for additional wells if existing wells have fully developed the aquifer. If this is the case, it may be necessary to go some distance to another aquifer.

An alternative might be to deepen the existing well(s) to obtain a greater quantity of water by tapping a deeper aquifer or reactivating an abandoned well. Well logs in some areas indicate that substantial yields of good water can be found at greater depths than those usually drilled. But highly mineralized water may be encountered by drilling deeper (Alexander and others, 1984). Again, all wells or other modifications to a system must be approved by the Office of Water Management, Division of Water Supply prior to their use as established under the Tennessee Safe Drinking Water Act.

Temporary Impoundments.

Public suppliers on streams might consider constructing a temporary impoundment. Guidance should be obtained concerning its feasibility and costs from consulting engineers (Smith and Lampe, 1982). Any temporary impoundment or other modifications to a system must be approved by the Office of Water Management, Division of Water Supply prior to their use. In addition, it will be necessary to obtain a permit for the construction of an impoundment structure from the Office of Water Management, Division of Water Pollution Control.

Water Recycling.

"The recycling of water intended for human consumption is a process which must be approached with caution." It is used only in extreme situations. "However, the reuse or recycling of water used exclusively in some commercial or industrial operations is common and should be considered by firms experiencing water shortage." Any community which is considering the recycling of water as an alternative water source should seek guidance and assistance from the appropriate State agencies with statutorily mandated water quantity and quality responsibilities (Alexander and others, 1984).

"The most conspicuous opposition to recycling for domestic use is likely to be that of uninformed individuals who object on general principles." However, most water suppliers on the downstream reaches of streams are treating water that has been reused repeatedly. The most serious technical problem associated with recycling is that treatment processes do not remove all dissolved minerals. Therefore, the several cycles may make the water too salty for further domestic use. "Other objections involve the resistance of viruses to chlorination and the concentration of heavy metals" (Alexander and others, 1984).

Modify Reservoir Management.

The State of Tennessee, through either the Office of Water Management or the Tennessee Emergency Management Agency, will work with the Tennessee Valley Authority and the U.S. Army Corps of Engineers to modify the operation of reservoirs where deemed necessary to satisfy critical needs. Availability of water on a regional scale impacts local water supply operations and environmental quality. Statutorily mandated objectives and responsibilities must be recognized to the greatest extent possible. Changing the operation of a reservoir system may be possible under some circumstances, provided the balance between different statutory objectives can be adjusted. Probable reservoir uses which would be effected include navigation and in-lake recreation.

Where reservoir releases are increased to meet downstream water supply needs, water quality impacts from a discharger are likely to lessen due to increased assimalative capacity. Increased releases also help protect critical habitat. Where reservoir management is changed to meet downstream needs, recreational users of reservoir pools should be informed of reservoir hazards due to poor water quality and/or low water level elevation (Keck, 1987).

Dredging to Improve Intake Capability.

"Another alternative for increasing available water supplies is to remove excessive deposits of silt and debris from the area surrounding community surface-water supply intake facilities. This is particularly true for those communities who get their water from small, unregulated streams or small surface-water impoundments." Communities sometimes have problems with siltation and clogging of water intake facilities as a result of excessive sedimentation and debris. Because environmental resources such as fisheries and other aquatic and waterfowl-wildlife habitat areas may be impacted, a state or federal water quality permit must also be obtained (Alexander and others, 1984).

Under "Emergency" Conditions

Under "Emergency" conditions, public systems will attempt to restore a system's integrity and must manage water to satisfy priority uses, such as hospitals and nursing homes, firefighting, and domestic drinking water. They may have in place contracts with vendors of bottled water to provide drinking water to homes without potable water. In addition, systems should furnish information dealing with sanitation and shutting down home water heating systems should these emergency actions be necessary. Procedures for dealing with non-drought emergencies will include not only priorities for water delivery, and starting up auxiliary equipment, but in addition, responses focusing on restoration of the system, and clean-up of a spill. The emphasis may be on restoring the system and protecting lives and property. "Emergency operation procedures" for every possible emergency should be developed for each water system depending on the class of emergency and based on available equipment, personnel, etc., listed in Appendix A, "Drought Management Planning Inventory For Public Water Supply Systems" (Keck, 1987).

For drought induced water shortages, **many of the responses appropriate under the "Restrictions" phase also apply under "emergency" conditions.** In some cases, rationing or other actions may be made more restrictive, reducing per capita allocations even further. Additional water management remedies include running a temporary pipeline to another source, and/or drilling an auxiliary water well. Suppliers should also consider the need to haul water to homes temporarily without service.

Hauling Water.

If all other water shortage responses fail to provide for First Class Essential water use needs, hauling water (by "water buffalo," etc.) may be necessary to protect the community and individuals from serious health, sanitary, and safety-related consequences. "However, the decision to haul water should be made only after all other responses fail because hauling water is expensive, time consuming, and unlikely to supply all of the water-related needs." Should the hauling of water be initiated, every possible conservation measure must be utilized, since hauled water can only satisfy essential water needs. Suppliers planning for this action must identify potentially needed equipment, vendors or lessors of equipment, potential water needs, and a corresponding capability (Alexander and others, 1984).

Because of the cost and difficulty of obtaining emergency supplies in this manner, the utility must establish measures to insure that the emergency water is used only for drinking, cooking, body washing, and other defined essential needs, not for general cleaning or outside use. This will insure that quantities of hauled water are minimized (Smith and Lampe, 1982).

Either raw or finished water can be hauled, but it is preferable to obtain finished water so that treatment of the water is not needed. "If raw water is hauled, the water must be treated in the utility's treatment plant, or, if the utility uses ground water and treats only with chlorination, the raw water must be treated in a portable treatment plant. If finished water is hauled, it should be emptied into the wet well for the finished water pumping facilities of the utility." If the utility normally obtains water pumped directly from wells into the distribution system, emergency pumps should be used for pumping the hauled water into the system (Smith and Lampe, 1982).

The equipment to haul water to the distribution point can frequently be obtained from local dairies, milk processors, road contractors, private water haulers, city public works departments, fire departments, and U.S. military bases or through the Tennessee Emergency Management Agency or Tennessee Adjutant General's Office. "Prior to use, the water tanks on the trucks should be cleaned and disinfected, and the water delivered should be chlorinated to a free chlorine residual of at least 2 mg/l" (Smith and others, 1982).

Total truck capacities required to meet basic water supply needs during an emergency must be estimated. For example, if emergency supplies were hauled to a community of 1,500 persons from a city 30 miles away, assuming a 24-hour per day operation, 3 trucks with a total capacity of 12,500 gallons would be needed to provide 50 gallons per person per day to the community.

(1,500 population x 50 gpcd) = 75,000 gallons per day
(24 hours   4 hour round trips) = 6 trips can be made per day
75,000   6 = 12,500 gallons per trip

Thus, two 5,000-gallon tank trucks and one 2,500-gallon tank truck would be adequate (Smith and others, 1982).

Bottled Water.

Similar to the option of hauling water is the option of providing bottled drinking water to customers of a system experiencing a water outage or being supplied with undrinkable water. Water systems planning this action must identify potential vendors, develop policies for distribution, and possibly establish a contigency contract with a vendor. Also, bottled water should be available at fallout and other emergency shelters.

Sanitation Measures.

Under the "Emergency" phase, water supply systems without water need to publicize sanitation needs, especially the safe disposal of human waste. Plastic bags and bucket-type containers need to be available at fallout and other emergency shelters, and homes for when water for sanitation is not available.

Each emergency, however, will be dealt with on a case-by-case basis. **Where the emergency cannot be resolved by the local water system, the state will consider remedies present within the watershed including the allocation of water between competing users, changes in reservoir management, obtaining necessary equipment, and assistance from nearby systems or communities.** Although most water supply shortages need to be handled locally to the largest extent possible, state agencies may become involved in coordinating efforts necessary to alleviate the water crisis on request to TEMA. Efforts may be directed toward water hauling, laying of temporary pipe, reallocation of water or any other actions necessary for mitigating the emergency. Funding of these emergency actions would be borne by the local community, to the greatest extent possible (Keck, 1987).

B. DEALING WITH WATER QUALITY PROBLEMS

Water suppliers may not actually experience a water shortage. But, because diminished supplies may affect surface water quality, taste, odor, and other problems may be anticipated. Drought can also lead to pressure losses within a system, resulting in an in-flow contamination of treated water. In addition to drought, systems should also plan for possible contamination due to earthquakes (linebreaks), sabotage, flood, hazardous materials spills, etc. Responses to these various water quality scenarios should be identified. Although various disasters may have common effects on a system, the water supplier must consider the system's water loss problems in light of impacts to other services and the need for coordination with many agencies. Remedies of water quality problems will depend on the degree of severity, available resources and other factors.

Where water quality problems result from reservoir management, public suppliers may request that the Office of Water Management approach the Tennessee Valley Authority and/or U.S. Army Corps of Engineers to modify the operation of a reservoir to maintain a water level or establish a flow necessary to maintain water quality or serve other purposes. It must be recognized that pursuing this alternative could adversely affect other uses for which the reservoir is normally maintained. Where reservoir releases are increased, downstream water quality is likely to improve. Where reservoir management is changed to meet downstream needs, in-lake water quality is likely to deteriorate.

In circumstances where streamflows cannot be altered or sufficiently improved on a regional scale, the Department could "post" stream segments not meeting standards. On federal reservoirs, the Department of Health and Envrionment could post those beaches which are unsuitable for body contact, reducing in effect the priority given to aquatic life and recreation (Keck, 1987).

Where a toxic or hazardous materials spill occurs, the Tennessee Office of Water Management (OWM) and the Tennessee Emergency Management Agency (TEMA) should be involved with cleanup efforts. Their involvement in coordinating emergency situations is well established in the Civilian Defense Act, the Water Quality Control Act, the Safe Drinking Water Act, and various Executive Orders.

Most water suppliers experiencing typical low-flow water quality problems, will have to provide additional treatment. Actions include changing the level of the raw water intake; adjusting the chlorine dosage; treating water with activated carbon, potassium permanganate, or ozone; a Boil Water Notice recommending physical or chemical disinfection; or supplying bottled water for drinking.

Most taste and odor problems occurring as a result of low flows are caused by the growth and decay of algae. Algal byproducts create a "musty" taste. The treatment to control algae tastes and odors consists of an alternate preliminary disinfectant and treatment with activated carbon.

The addition of chlorine to a raw water containing decaying algae may intensify taste and odor problems. Modifying the preliminary chlorine dosage or changing to another oxidant such as potassium permanganate, ozone, or chlorine-dioxide may decrease the effect of the algal byproducts released by the algae.

Treating the water with activated carbon will reduce taste and odor problems from algae growth. Activated carbon has a porous structure containing many sites for the adsorption of chemical compounds which cause taste and odor complaints. Activated carbon is added in a powdered form to the water for the removal of these chemical compounds. The carbon is removed from the water by settling or by filtration.

Aeration will help to increase dissolved oxygen, and oxidize iron and manganese. When organic matter is high, increasing normal treatment helps.

Where the taste and odor of water are unacceptable, systems may continue to supply water for most uses, and encourage bottled water for drinking. In cases of spills, where a water system must shut down an intake or take other drastic measures, bottled drinking water may be necessary. Water suppliers should include in their emergency plans arrangements for the distribution of bottled drinking water, or provisions for hauling water to customers. Water suppliers encountering water quality problems can obtain technical assistance from the Office of Water Management Fleming Training Center, Murfreesboro, Tennessee (615/470-8090).

Where excess water use causes reduced pressure, resulting in inflows of untreated water, systems may need to valve-off tanks and lines, make repairs if necessary, and decontaminate lines before restoring service. A good cross-connection program may help to avoid some of these problems.

Where a local/regional response to a water quality problem is inadequate, the Office of Water Management has authority, under the Commissioner's or the Governor's emergency powers, to mediate or resolve water use conflicts between competing users, in order to protect the environment (Water Quality Control

Act, T.C.A. Section 69-3-109(b)). In a declared water shortage emergency the Office of Water Management could allocate water among competing users. The authority for this power can be found under the [redacted] 58-2-510) and Executive Order No. 4. Where minimum standards are not being met in the provision of safe drinking water or where compliance with a locally adopted water emergency management plan is inadequate, the supplier could be subject to Orders issued by the Commissioner of the Department of Health and Environment, the Safe Drinking Water Act, T.C.A. Section 68-13-710) (Keck, 1987).

Where water quality problems are the result of a loss of pressure, linebreak, flood, major fire or other hazard, the critical factors must first be identified and established procedures for that emergency followed. These should be developed and included in the "Emergency Operations Procedures" portion of the water system's drought and emergency management plan. Where water service has been restored following a linebreak, or "in-flow" water quality problem, systems may need to have additional water quality analyses made by a laboratory certified by the Department of Health and Environment.

C. SURVEILLANCE SYSTEM

When conditions are conducive to drought, a close watch should be kept on water supplies and uses by suppliers. An increased use or abuse of water, including the contamination of supplies, can signal activation of a phase. Refer to chapters VI and VIII "Assessing Source Capacity" and "Identifying Management Triggerpoints" for what should be monitored.

Utility districts and municipal systems are responsible for monitoring impoundment levels, streamflows, and water levels in production wells. In addition, suppliers must prepare for treating water quality problems induced by drought. In some instances, sub-components of the system may need to be monitored, such as monitoring supply and demand on a weekly basis or more frequently as conditions warrant.

Monitoring supply and demand is the basis for changing response levels and deciding how to allocate existing supplies. At a minimum, the community should prepare water availability estimates, evaluate remaining supplies at various usage levels and consider their ability to monitor fluctuations in water supply (Wood and others, 1986). Where water supply data is provided by others, data reporting arrangements must be made. Arrangements would also be needed if existing staff are to be used to gather data in addition to the normal duties.

In addition, systems should check for progress in reducing water use. It may simply involve more frequent reading of meters in selected areas of the distribution system. A system surveillance should be more detailed and encompassing with each progressive stage.

Surveillance is therefore important not only for phase activitation, but enforcement. The means for achieving the end-result must be both practical and appropriate. Each required response in a phase must be enforceable.

Planning the surveillance and enforcement elements of a drought water management plan avoids uncertainty and last minute, crisis-moment decisions. It is wise for a supplier to choose to establish an advisory group to assist in plan development and to validate implemented actions.

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XI. PLANNING FOR IMPLEMENTATION

Once all other plan elements have been dealt with (i.e., the capacity of the source assessed, demand projected, uses classified according to some priority, local actions in response to various drought phases balanced, impacts identified, and the community served by the system satisfied by the strategy and plan) water system public officials must evaluate each measure for reduced water use and enforceability.

If each plan element seems viable, the system must then develop an ordinance or by-law enabling it to implement its drought management plan. The adoption of an ordinance legally defining and authorizing the plan is essential to implementation. Also, essential is development of a program to educate users about water conservation and the planned responses under the various phases of water management. A plan should also be developed for notifying customers of phase activitation due to a drought.

A. ASSESSING THE ABILITY TO ENFORCE

Enforcing the measures prescribed under each water management phase deserves attention. Where measures are voluntary or tied to pricing structures, enforcement procedures are not applicable. However, where measures are mandatory, the water supplier should determine what management actions and resources are needed to enforce the provisions of the plan.

The local water system (alone or in cooperation with other area systems) is responsible for informing customers of conservation measures to be taken. Also, each system is responsible for the costs associated with mandatory restrictions and bans. Additional costs are likely to result from overtime pay to system employees and temporary help to make more frequent meter readings, additional treatment costs, water purchases, make repairs, clean-up a spill, haul water from other systems, or other actions.

Additional financial burden to a utility may come from reduced income where water conservation measures are effective. However, this problem may be irrelevant where the system is operating at its maximum. Revenues may be maintained or even improved where a pricing program is used to reduce water consumption. Standby rate structures can help off-set enforcement costs. Where the supplier is a local unit of government, the police department and other agencies of government may be able to assist in enforcement.

Systems must be prepared to enforce restriction and bans with fines and penalties. These must be built in appropriate ordinances if the water supplier is a local government. A utility district may issue warnings, impose surcharges, and suspend service for various periods of time if measures are not taken by a customer. A mechanism must also be established within the ordinance for granting variances (relief from compliance). There will be unique circumstances and hardships which must be allowed some flexibility.

Where penalties and other payments are not made, suppliers might consider disconnecting that customer until payments are received. Without tough provisions for enforcement, a water supplier cannot expect to achieve its planned goals and objectives. Systems unable to achieve adopted plan goals and objectives under any phase of implementation would be subject to enforcement by the Commissioner of the Department of Health and Environment.

Plans should include personnel assignments given the various management situations and detailed procedures for the well-being of personnel. Personnel may need to be reassigned to duties they do not normally perform depending on the nature of the emergency. This means that management and personnel must be familiar with tasks they might have to perform under drought conditions. Periodic "dry runs" through these procedures will train the personnel and give them the expertise that may be called upon during a drought or other emergency.

B. ADMINISTERING MANAGEMENT PHASES

The primary reasons for developing a drought management plan is to have management guidance when the need arises. Procedures for implementing the plan must be outlined by the management plan, as well as provided for in an ordinance or by-law.

Where an emergency arises which is not the result of a drought, many additional responses may be necessary. These will vary according to the emergency, and the actions outlined by the system to address the emergency given their resources. Developing "emergency operations procedures" (EOPs) is discussed in detail in the Division of Water Supply's "Guidelines for Emergency Operations Planning for Community Water Systems."

The "Drought Alert" phase is important to initiate drought management responses because customers, other utilities, and government entities need to be informed in advance that water supply/use conditions are conducive to a water shortage. Procedures necessary for activating and de-activating a drought response must be clearly established. A water supplier must have a plan for notifying its customers in a timely manner about emergencies or other necessary responses. A list of media contacts, containing names and phone numbers for radio and television stations, and newspapers should include in the management plan. Implementation plans should also include (Texas Water Development Board, 1986):

1. automatic regulatory provisions;
2. prearranged media notification or press release procedures;
3. communications procedures including paging of emergency personnel, and means of public notification (telephone, police car public address, leaflets left door-to-door, etc);
4. prearranged contract procedures to obtain emergency water supplies from other sources if needed;
5. emergency checklists, personnel assignments and established operating procedures, as necessary; and
6. procedures and forms for documenting management actions taken.

In addition to these, several legal or regulatory components may be necessary for implementing phases of the plan. These may include (Texas Water Development Board, 1986):

- Ordinances, bylaws, or other implementing legal documents;
- Changes in plumbing codes;
- New or revised contracts with potential water suppliers;
- Conditions in contracts tied to drought phases with industries or commercial water users who may have water supplies cut off or curtailed; and
- Changes in contracts with current water suppliers.

The decision to terminate a drought management phase must be based on sound judgement by proper city or utility authorities. In some instances the stepping-down of phases may be appropriate. The city or utility should also have a written procedure to inform customers that a particular phase is no longer in effect or that drought management is being discontinued or terminated (Texas Water Development Board, 1986). Actions leading to the activation and de-activation of phases should be clearly specified and based on triggerpoints established in the drought management plan. Water suppliers are encouraged to consider deactivating plan phases in the reverse order of their implementation.

Copies of the drought management plan and/or EOPs should be on file with local law enforcement officials, the local emergency planning agency, fire department, appropriate state agencies, adjacent water systems and others who may have a need for the information during an emergency. A list of those with a copy of the plan should also be kept and updates sent to them as revisions to the plan are made. In addition, multiple copies of records, maps and engineering plans kept at locations remote to the plant should be considered.

C. ADOPTING THE ORDINANCE

A water department must have legal authority for the implementation of a drought management plan. They must have the authority to affect or alter existing plumbing codes, establish a leak detection program, or commit the water system to a mutual aid agreement with another system. A model water shortage ordinance is contained in Appendix D, "Water Shortage Ordinance."

This representative ordinance reflects a municipal water supply system utilizing a city reservoir. Other systems might utilize some other triggering mechanism. Appendix D also contains a classification system involving industry and institutions. (This component may not be applicable inasmuch as many utility districts in Tennessee do not serve industry or large institutional users. The ordinance also contains other features which may not be applicable.)

A system may not wish to adopt a stand-by rate structure, opting for rationing instead. An effective drought management ordinance should address all of the actions selected to respond to water shortage conditions.

D. OPERATIONAL CHANGES

In addition to prioritorizing water uses, establishing a drought management price structure, and establishing mutual aid agreements, water systems may need to purchase bullhorns, or put 500 feet of line in place to a neighboring system in order to effect a mutual aid agreement if it were needed. Other water systems may have determined that reducing their vulnerability to risk requires that they also invest in a number of "harder" solutions. They may have identified a number of measures they could implement with existing financial resources. They may have identified the lack of an emergency power source, or insufficient accessable records. Reducing some risks in many instances may not necessarily require the construction of a finished water storage tank, plant expansion, or other major capital improvement but merely acquiring equipment to isolate parts of the system, or having printed leaflets available.

Systems should review their plans and EOPs for those operational changes which are necessary to make valid the management measures outlined in their plans.

Operational changes may involve:

- additional pumps, valves, and other equipment, chemicals, or supplies;
- copies of records, maps and engineering plans at additional locations;
- identification of spokesman;
- fences around water system facilities;
- maintaining emergency placards, loudspeakers, and mobile communications equipment;
- trained emergency personnel;
- emergency shelters for water treatment personnel;
- monitoring and detecting equipment;
- portable power supplies; and
- other operational changes as may be needed to implement any of the management phases detailed in the plan, including any of its emergency operations procedures (Agardy and Ray, 1973).

E. PUBLIC EDUCATION

Education is the key to the success of a conservation/drought management program because it can help users understand why water conservation is needed and how to conserve water. "It can also successfully minimize opposition to water conservation programs and can improve water supply planning coordination among community officials." The public should be informed of what will be expected during a drought or water emergency (New England River Basin Commission, 1980).

"Education is most effective during a water crisis when user awareness of water is high. At other times, users need constant reminders of the need to conserve." Therefore, educational programs should be on-going (New England River Basin Commission, 1980). Table 3, "Suggested Audiences, Messages, and Communication Techniques For A Public Information Program" provides a list of approaches a water supplier might use.

"It is questionable that a particular public education campaign will result in a certain amount of water savings; often public education works only in conjunction with more direct conservation efforts, such as plumbing retrofit programs. Public education is effective on its own mainly during obvious emergencies, and the behaviors it induces are usually short-lived." School programs can teach children water-saving habits, and can possibly teach parents as well (New York State Senate Research Service, 1986).

There are many methods of public education, including (New York State Senate Research Service, 1986):

- developing citizen involvement through public interest groups;
- establishing speaker's bureaus to make presentations to schools, businesses, and service organizations;
- newspaper articles, public service announcements, and news stories;
- developing and distributing films or slide shows;
- radio and TV talk shows and interviews;
- promotion conferences, symposia or seminars;
- distributing pamphlets, brochures, leaflets, and posters promoting conservation;

- encouraging board of education involvement;
- bumper stickers, buttons, and decals
- conducting public demonstrations, displays and distribution at malls and shopping centers, schools, and booths at fairs;
- encouraging restaurant tri-folds which explain water use, for instance, for ice making and filling and washing of drinking glasses;
- enclosing water bill inserts and distributing newsletters to non-customer water users such as apartment dwellers; and
- free distribution of inexpensive flow restriction devices on doorknobs.

Educational material should make direct connections between conservation activities and monetary savings, from the points of view of both consumers and water suppliers.

Give as much information as possible and be specific about what you want the public to do. A water conservation program should be individualized to meet the needs of the community. Customers cannot be expected to cooperate until they are informed. This is particulary important when regulatory and/or pricing measures are being implemented.

Specific voluntary and regulatory measures being promoted will depend on the responses selected by the system as appropriate. An exhaustive list of optional responses is contained in Chapter X, "Dealing with Shortages and Water Quality Problems." Examples of direct mail fact sheets, bill inserts and articles are contained in Appendix B, "Obtainable or Adaptable Water Conservation Education Materials."

Public education should be an integral part of any system's water supply management program. A water system should develop a strategy and plan for educating its customers. The strategy should be appropriate to the community it serves. It may not be practical to develop TV public service announcements where the system is small and serves few of the TV station's viewers.

Developing presentations for school-age children geared to convey information about "restrictions" and/or "emergency" responses initiated during the summer are not likely to be effective. However, programs that teach water conservation practices to school children may be more permanently successful. Typical press releases are contained in Appendix E, "Sample Press Releases and Declarations."

F. PLAN UPDATES AND REVISIONS

The need to update a local drought management plan may be self-evident after the plan has been activated by a water supplier. Needs which were not addressed, inappropriate triggerpoints, or unsuitable responses may be identified. Other factors which require a drought management plan to be updated include population or industrial growth served by the public water supplier, changes in industrial mix, infrastructure condition, lower risk requirements of users served, major equipment changes, or any other condition altering the public supplier's circumstances. To insure that local drought management plans are evaluated and updated, public suppliers should review and modify adopted plans within three (3) months of deactivating any of its drought management phases or every two (2) years.

Table 3

SUGGESTED AUDIENCES, MESSAGES, AND COMMUNICATION TECHNIQUES FOR A PUBLIC INFORMATION PROGRAM (INTASA, INC., 1982)

Key Audience	Key Motivating Message(s)	Particularly Appropriate Techniques
Home owners/ apartment renters	. Flow reduction measures save water, energy, and dollars with minimal cost, little effort and no inconvenience.	. Water bill inserts. . Media public service announcements.
	. Flow reduction saves tax dollars by decreasing community expenditures for building and operating treatment facilities.	. Presentations. . Exhibits of devices and cost saving information. . Treatment facility tours.
Apartment owners	. Retrofitting rental units save money at minimal cost and with no tenant dissatisfaction.	. Information flyers mailed to landlords.
Civic groups, public interest groups (e.g. Lions Club, Sierra Club, League of Women Voters	. As concerned community leaders, they can ignite the program.	. Presentations at meetings to encourage active support and suggest activities they can do.
Homebuilders Association	. Water-saving features can enchance the attractiveness of homes to potential buyers.	. Workshops or meetings of member representatives.
	. The program represents an opporunity to enhance public visibility and improve their image.	. Information flyers.
Hardware and plumbing supply store owners and managers	. Increased sales revenues can be obtained if they advertise, display and stock water-saving devices.	. Workshops or meetings. . Information flyers.
School children	. Saving water is fun.	. Puzzles about conservation.
	. Saving water is something they and the family can do at home.	. Math problems showing water, energy savings. . Essay/poster contests. . Take-home class assignments on reading water, gas meters.
Scout troops and youth groups	. Flow reduction activities can be fun and help the community.	. Activities to earn a water-saving badge or certificate. . Presentations at club meetings. . Contests of exhibits f display at fairs or or shopping centers.

LK:E6028104

GLOSSARY

The following terms are defined as they are used in this guide.

"3Q20" is the low flow for a stream or spring which can be expected to occur over a three-day period once in twenty years on the average. In Tennessee the 3Q20 is used in planning for the discharge and assimilation of liquid wastes into a stream.

"Activated carbon" is a highly adsorbent powdered or granular material used for purifying water. Also called activated charcoal.

"Aerator" is a device that exposes water to additional air.

"Aesthetic water use" means the use of water for fountains, waterfalls, and landscape lakes and ponds where such uses are primarily ornamental.

"Agricultural drought" generally involves soil moisture and plant behavior. It occurs when the amount of water needed for transpiration and direct evaporation for a particular crop exceeds the amount of water available in the root zone of that crop.

"Agriculture water use" or "irrigation" refers to the use of water for the production of crops and for freeze protection.

"Alert" refers to "Drought Alert."

"Allotment" is used to mean the maximum quantity of water allowed for each customer over any applicable period as established in the water rationing provisions of an ordinance.

"Any water" is used to mean any type of water, including fresh water, brackish water, wastewater, or reclaimed water.

"Aquifer" is a geologic formation that stores, transmits, and yields significant quantities of water to wells and springs.

"Atmospheric drought" involves precipitation and possibly temperature, humidity, wind speed, or sunshine.

"Average Daily (Water) Use" is the average amount of water withdrawn for processing and distribution by a public water supply system to meet users' daily water demands. This amount is usually based on the system's average monthly use over a 12 month period.

"Average Streamflow" is the average of all the mean daily flows for a stream or river. The average flow characterizes the yield of water from a particular basin.

"Backflow" is a reversal of normal water flow direction.

"Base-period" refers to a a specified period during which water use is calculated.

"Ban"

"Blue-green algae" is a type of algae typically responsible for creating taste and odor problems in finished water.

"Boil Water Notice" is a public announcement to the customers of a water system that conditions indicate bacteriological contamination of the water may have occurred and that water should be strained through a clean cloth to remove any sediment and vigorously boiled for 2 minutes before being used for human consumption. Where contamination involves heavy metals, organic compounds, etc., boiling is not effective.

"cfs " (cubic feet per second) is a measure of the amount of water passing a given point. A cubic foot of water equals approximately 7.5 gallons.

"Commercial/industrial water use" refers to the use of water for the production of goods and/or services by an establishment having financial profit as the primary aim.

"Component" is a discrete part of a system capable of operating independently but operated as an integral part of a system.

"Conservation" means a reduction in usage of a resource to prevent its depletion or waste. It is the efficient use of available water.

"Conservation device" is a mechanical device used to reduce water use.

"Conservation measure" is a change in the behavior of people that results in a reduction of water use.

"Conservation phase" is the term used to refer to a period of below normal water supply and/or inadequate water quality conditions.

"Consumption" refers to that water withdrawn from a source that is used and not returned to that source because of evaporation or product incorporation.

"Customer" is a term which means any person, company, or organization using water for any purpose supplied from the system's water distribution system and for which a charge is made.

"Deliverable capacity" of a system is the lesser of either the source capacity or the system's capacity.

"Design capacity" is the maximum amount of water a drinking water ~~treatment~~ or wastewater treatment plant was built to treat.

"Design volume" is the amount of water a reservoir was originally designed to hold.

"Diffused surface water" means waters lying, or running on the surface of the earth but not in definite courses, streams, or waterbodies.

"Domestic water use" means any use of water for personal needs or for household purposes; such as drinking, bathing, heating, cooking, sanitation, or cleaning, whether the use occurs in a residence or in a business, industrial, or institutional establishment~~s~~.

"Drainage basin" is the land area that contributes water by runoff or underground flow to a surface body of water.

"Drawdown", usually measured in feet, is the distance that the water level in a well falls from the static water level to the level at which it stabilizes when the pump is running.

"Drought" is an extended period of dry weather conditions (prolonged and abnormal moisture deficiency) which results in declining streamflows (generally flows near or below a 3Q20), depressed reservoir pool levels, depleted soil moisture, and/or lower groundwater levels. A drought may be of one or more of several types: agricultural, hydrologic, meteorological, atmospheric, etc.

"Drought Alert" is a term used to publicize a need to evaluate water use. It is used to advise an area that it is experiencing lower than normal precipitation, declining streamflows, reservoir levels or groundwater levels, and that if these conditions continue to decline, water supplies may not be adequate to meet normal needs. Users should monitor for source quantity and quality problems as well as for hydraulic stress and the possible need for water conservation measures.

"Drought emergency" exists as declared by an official or administrative head when the safety, security, health, or welfare of citizens are threatened. It may not necessarily mean the implementation of measures outlined in a plan's "emergency phase."

"Emergency" from a water supply standpoint is used to mean a period during which water supplies are below the level necessary to meet essential needs within the system or a sub-area of the system, requiring the implementation of emergency measures. It also includes supplies where water quality poses serious risk to water users. In addition to drought induced, a water supply emergency may be caused by a tornado, storm, flood, wind, earthquake, landslide, snowstorm, fire, explosion, civil disorder, dam failure, hazardous materials spill, power failure, nuclear attack or other catastrophe.

"Emergency Operations Plan" or "EOP" refers to the plan required by the TN Div of Water Supply.

"Emergency Operations Procedures" or "EOPs" refer to sets or lists of actions which are used as guidelines during a drought or other emergency in assessing its extent, and then in obtaining, commiting, and applying resources to alleviate the identified needs. They should prescribe in sequential order: who, what and under what conditions, existing resources are utilized. Emergency Operations Procedures may prevent costly and potentially dangerous spur-of-the-moment decisions from being made. pp. 43, 84 & Appendix F, p. i

"Essential water use" is a classification of water uses to be part of a drought or emergency management plan. Essential water uses are priortized further into First, Second and Third Classes.

"Evapotranspiration" is the loss of water through transpiration from plants and evaporation from land and water surfaces.

"Even numbered address" means the street address, box number, or rural route ending in the numbers 0, 2, 4, 6, 8, or the letters A-M; and locations with no addresses.

"Even numbered days" means the days whose dates end in the number 0, 2, 4, 6, or 8.

"Excess use" is a term used to mean the usage of water by a water customer in excess of the water allotment provided under water rationing provisions over any applicable period.

"FEMA" refers to the Federal Emergency Management Agency.

"Finished water" means water withdrawn from a surface or groundwater source which has been treated and is potable.

"Fish kill" is an event during which large numbers of fish in a water body are killed by toxic substances, oxygen depletion, high water temperatures, etc.

"Float valve" is a device that controls how much water is allowed to enter the tank of a toilet.

"Flow-regulated stream" is a stream or river in which the amount of flowing water is controlled by releases from the dam of an upstream reservoir or impoundment.

"Flow-restricting device" is a device by which the amount of flow in a pipe, conduit, showerhead, etc. is reduced.

"gpd (gallons per day)" is a measure of water use, streamflow, etc. To convert gpd to million gallons per day (mgd), divide gpd by 1,000,000.

"Hydraulic problems" refer to water system problems resulting from inadequate pump capacity, distribution mains, low pressure, limited treatment capacity, etc.

"Hydrologic Drought" is characterized by a reduction in streamflows, lake or reservoir levels and lower than normal groundwater levels.

"Hydrology" is the science ~~of~~ ~~(~~or study of~~)~~ the origin, properties, distribution, and circulation of water~~s~~ of the earth including precipitation, streamflow, infiltration, groundwater storage, and evaporation.

"Impoundment" is a body of water, such as a pond or lake, confined by a dam, dike, floodgate, or other barrier.

"Institutional water user" refers to water used in activities and facilities for such diverse entities as, but not limited to, hospitals, nursing homes, government, public or private schools or universities, prisons, churches and places of worship, etc.

"Instream water use" takes place within the stream for such purposes as fish and wildlife habitat, recreation, navigation, waste assimilation, and hydropower generation.

"Lagoon" in wasterwater treatment, is a shallow pond usually manmade where sunlight, bacterial action, and oxygen interact to restore wastewater to a reasonable state of purity.

"Landscape water use" includes water used to maintain gardens, trees, lawns, shrubs, flowers, athletic fields, rights of way and medians, but excludes nurseries and golf courses.

"Low-volume hand-held watering" means the low-volume irrigation of plants and crops with one hose, fitted with a self cancelling or automatic shutoff nozzle attended by one person.

"Mandatory allocation" is the rationing of available water supplies by a governing body among the various water uses.

"Meterological drought" is a prolonged and abnormal deficiency in precipitation for a given area, over a period of months or years, from that which is climatically expected.

"mgd (million gallons per day)" is a measure of water use, streamflow, etc. To convert mgd to gallons per day (gpd), multiply mgd by 1,000,000.

"Monitoring" is the process of regularly measuring and analyzing water supplies for quality and/or quantity.

"NOAA" refers to the National Oceanic Atmospheric Administration, United States Weather Office.

"Non-essential water use" is a classification of water uses to be part of a drought or emergency management plan. Typically, it will refer to water used for fountains, law watering, irrigation of recreation areas, filling of swimming pools, and the washing of streets and sidewalks.

"NWS" refers to the National Weather Service.

"NWSFO" refers to the National Weather Service Forecast Office.

"Odd numbered address" means the street address, box number, or rural route ending in the numbers 1, 3, 5, 7, 9 or the letters N-Z.

"OWM" refers to the Tennessee Office of Water Management, Department of Health and Environment.

"Oxygen depletion" is the process of removing oxygen from ~~the~~ water, more often associated with pollutants discharged from municipal or industrial wastewater treatment facilities, and the decomposition (breakdown) of plant or animal remains in the lower levels of lakes or in slow moving rivers during times of elevated temperatures.

"Palmer Index" is a measure of the severity of a drought or a wet spell in an area's soil moisture. Dry conditions are associated with negative values, wet conditions with positive values, and normal conditions have a value of zero.

"Percent reduction in overall demand" means the weight average reduction of all water uses within a source class regardless of the type of use or method of withdrawal, which is necessary to reduce estimated present and future demand to estimated present and future available water supply.

"Per Capita Water Use" is the amount of water used by one person per day.

"Person" means any and all persons including individuals, firms, partnerships, associations, public or private institutions, municipalities, political subdivisions, governmental agencies, or private and public corporations organized under the laws of this state or any other state or country.

"pH" is an expression of acidity or alkalinity of water on a scale of 0 to 14. A pH of less than 7 indicates acidic water, and a pH above 7 indicates alkaline water.

"Potential Water Shortage" is a situation in which the "source capacity" of a specific system's source of water is less than, or equal to the system's peak capacity.

"Precipitation" is the fall of water in any form upon the earth's surface. It includes rainfall, snow, sleet, hail, and dew.

"PSI" refers to pound per square inch of pressure.

"Public Water Supplier" refers to municipal water systems, departments, water commissions, utility districts and investor-owned systems serving at least 15 connections and/or 25 people at least 60 days per year. The supplier's primary mission in any emergency is to maintain or restore delivery of potable water. Other services or relief, such as providing emergency shelters, etc., may or may not the responsibility of a public water water supplier. Disasters that are more extensive will require the coordinated management action of many agencies having different missions. The local emergency planning committee (or county emergency management agency) should develop plans and procedures for handling multi-service coordination.

"Rationing" is the restriction of water usage in order to insure equitable distribution of critically-limited water supplies, in order to balance demand and limited supplies, and to assure that sufficent water is available in the future to preserve public health and safety.

"Reclaimed water" is wastewater which has been treated to allow reuse.

"Reservoir" is a pond, lake, tank, or basin, natural or manmade, used for the storage, regulation, and control of water.

"Runoff" is water from precipitation that eventually enters a stream or reservoir; especially water flowing over the earth's surface.

"Raw water" is water that has not been through any treatment process.

"Residential customer" is used to mean any customer who receives water service for a single or multi-family dwelling unit. The term residential customer does not include educational or other institutions, hotels, motels, or similar commercial establishments.

"Residential use" refers to any water for personal needs or for household purposes such as drinking, bathing, heating, cooking, sanitation, cleaning, outside watering, or sprinkling, and water used for private swimming and wading pools.

"Restrictions" or "restricted"

"Restrictions phase" is the term used to refer to actions affecting water users in responding to specified continued declines in water supply, possibly due to water quality.

"Riparian rights" are the common law rights of a land owner to the water on or bordering his property, including the right to prevent diversion or misuse of upstream water.

"Risk" is vulnerability to a hazard, in this case a water shortage. The degree of exposure to risk will depend on how likely the various situations are that can cause a water shortage. Some events are not very probable and are not worth worrying about, others are likely. Risk also must consider all potential impacts resulting from a water shortage, i.e, social, economic and environmental. An "acceptable level of risk" is generally determined by those who must pay the additional cost necessary to improve the reliability of their supply.

"Runoff" is the portion of rainfall, melted snow that flows across ground surface and eventually is returned to streams. Runoff can pick up pollutants from the land or air and carry them to the receiving waters.

"Sediment" is soil that erodes from the land and is carried by runoff; it travels in water producing a turbid, brown appearance or settles to the bottom of a reservoir or other slow-moving body of water.

"Safe yield" is the available amount of water that can be expected from a reservoir, stream, or groundwater source during a critical dry period. It is generally the 3Q20 for a non-regulated stream, the pump tested yield of a well, the average daily flow in a regulated stream, or the 90 day sustainable yield of a reservoir. Optimally, the safe yield of a source should equal or exceed the system's capacity to deliver water. Greater risk is assumed when the safe yield of a water source in drought can only meet the water demands of either the "Restrictions" or "Emergency" phase.

"S.A.R.A." refers to the "Superfund Amendments and Reauthorization Act of 1982." "Emergency Planning and Community Right-to-Know" is Title III of S.A.R.A.

"Service interruption" refers to the temporary suspension of water supply or reduction of pressure below that required for adequate supply to any customer, portion of a water supply, or the entire system.

"Sonar device" is an instrument used to measure drawdown in wells by the use of sound waves.

"Source capacity" is the water yield of a particular surface-water or groundwater source. The safe yield of a source is generally the 3Q20 flow of an unregulated stream, the pump tested yield of a well, or the minimum average daily flow of a regulated stream.

"Specific capacity" is an index of the efficiency of a well, measured in gallons per minute per foot of drawdown (gpm/ft).

"Static water level" is the level of the water in a well before pumping begins.

"System capacity" is the maximum amount of water a treatment plant can effectively process and deliver. When a system's average daily use reaches 80 percent of the system's design capacity, the manager of the system should consider expanding the system's treatment plant capacity. The system's capacity should not exceed the safe yield of the source.

"TEMA" (Tennessee Emergency Management Agency) is the state agency responsible for coordinating emergency assistance to supplement local efforts.

"Toilet tank displacement insert" is a device placed in a toilet tank to reduce the volume of water held in the tank.

"Toxic substances" are chemicals that can produce sickness, death, or abnormalities if consumed or, in some cased, contacted.

"Triggerpoint" is a predetermined condition at which point particular action is taken, such as a declaration of a "Conservation" phase requesting users to utilize water conservation measures.

"TVA" is an abbreviation for the Tennessee Valley Authority.

"Use class" means the category describing the purpose for which the user is utilizing water. Four classes are recommended: Essential, First Class; Essential, Second Class; Essential, Third Class; and Non-essential.

"User" means any person, individual, firm, association, organization, partnership, business trust, corporation, company, agent, employee or other entity, municipality, or public agency, thereof, which directly or indirectly takes water from a specified water resource.

"USGS" refers to the United States Department of the Interior, Geological Survey.

"Waste of water" refers to water use exceeding the generally accepted normal water use for each individual water use category. It may also include water escaping down a ditch, or other surface drain, or lost by a leak due to defective plumbing.

"Wastewater" refers to water which has been previously used for industrial, municipal, domestic, or other purpose and must be treated prior to its return to a surface or groundwater source. It is waste carried by water.

"Water" refers to the water available to the city or utility district for treatment by virtue of its water rights or any treated water introduced into its water distribution system, including water offered for sale.

"Water conservation" means the short- or long-term reduction in water use, whether by mechanical device or human behavior, to prevent its depletion or waste. It can be accomplished by reducing the overall demand for water, improving water use efficiency, recycling and reusing existing water, and reducing water losses through leak detection and repair.

"Water Management Advisory Group" or "Drought Response Committee" refers to the committe of local representation whose purpose should be to advise and oversee drought responses by a management agency.

"Water resource" means any and all water on or beneath the surface of the ground, including natural or artificial water courses, lakes or ponds, and water percolating, standing, or flowing beneath the surface of the ground.

"Water shortage" refers to inadequate amounts of water to meet the present or anticipated needs of a water user or users. A water shortage requires temporary reductions in total use within a particular area to protect water resources from being seriously depleted. A water shortage may stem from drought, but may also result from broken water mains, distribution lines, inadequate treatment capacity, and other causes.

"Water shortage emergency" means a situation when powers are exercised to protect the public health, safety, or welfare; the health of animals, fish, or aquatic life; a public water supply; or commercial, industrial, agricultural, recreational, or other reasonable uses.

"Water withdrawal" refers to water withdrawn or diverted from a surface-water or groundwater source for a specific purpose.

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APPENDIX A

DROUGHT MANAGEMENT PLANNING
INVENTORY

FOR

PUBLIC WATER SUPPLY SYSTEMS[1]

1. Name and address of the water supply system:

   System name ______________________________

   Mailing address ______________________________

   City ______________ State ____________ Zip code __________

2. Name and position of person(s) to contact for further information (plant manager, operator, owner, etc.):

   Name ______________ Position ____________ Phone __________

3. Operation location and general description of the system's service area.[2]

   City ______________ County ______________

   Service area (a map showing the service area would be helpful):

   ____

   ____

   ____

4. Time period for which water use data are being provided:

   12-month period beginning: Month __________ Year ________
   Seasonal use beginning: Month __________ Year ________ to
   Month __________ Year ________

5. Source(s) and amount of supply:

Source of Supply by Name or Number	Water Supply Intake Location	Average Daily Amount Withdrawn or Purchased on Operating Days (Gallons Per Day)	Percent of Total	3Q20 or Pump Test Yield if Known
Streams[3]:				
Wells[3]				
Springs[3]				
Lakes or Ponds[3]:				
Other Supplies[4]:				
Total			100	

Describe the contractual agreements your system may have with other suppliers, specifying the amount to be supplied under various conditions and system contracts. (including drought or an emergency)

6. What percentage of the total average daily withdrawal shown above is metered?__________ Estimated?__________

7. Normally, this system operates __________ hours per day, __________ days per week and __________ weeks per year.

8. Average amount of water reused or recirculated in gallons per day (GPD) on normal operating days: __________ GPD

9. Total water use (average daily withdrawal plus reuse): ____________ GPD

10. Historical peak water use: ____________ GPD

Frequency of near peak water use:

____

Approximate time(s) of peak water use (hours of day, days of week, month, and season of year): ____

____

11. Specify the location of treatment plant(s) and describe the type of treatment including major processes and the maximum design treatment plant capacity in gallons per day[2]: ______________________________

____

____

12. Describe distribution facilities[2]:
Diameter of distribution lines: ____________ Average Age: ____________
Diameter of high service lines: ____________ Average Age: ____________
Number of pumps: ____________ Pump sizes: ____________

13. What percentage of the distributed water is metered? ____________
Estimated? ____________

14. Total storage capacity for treated water by type of storage[2]:

Type	Amount of Storage (Gallons)	Overflow Elevation
Tanks	____________	____________
Clear wells	____________	____________
Reservoirs	____________	____________
Distribution lines and mains	____________	____________
Other	____________	____________

15. Describe how and where records on the location of water lines, system valves and hydrants, storage facilities and pumping facilities are kept (i.e., map, computerized, etc.)

____

____

16. Number of connections by type: residential ____________, commercial ____________, and industrial ____________.
Number of people served by this system: ____________.

17. Describe the water use records maintained by the system, i.e., basic data maintained, categories of use, and if computerized.

____

____

____

18. Number of multiple units with only one meter: ____________________

Name	Address	Units

19. Average daily amount of water in gallons per day supplied by this system for each of the following purposes:

Sale to other towns and utility districts	____________
Industrial	____________
Commerical	____________
Residental	____________
Public supply[5]	____________
System losses[6]	____________

Estimated Monthly Water <u>Sales</u> by User Category in Gallons (Use latest typical year)

	Residential	Commercial	Industrial	Towns
January				
February				
March				
April				
May				
June				
July				
August				
September				
October				
November				
December				

20A. Identify below all other towns or utility districts, if any, purchasing water from this system:

20B. Specify the contractual conditions contained in each agreement:

Name and Address of the Purchasing System	Average Amount of Water Purchased Per Month (GPD)	Contact Point Name and Telephone Number

21. Identify below all industrial and commercial customers purchasing more than 2,000 gallons of water per day from system.

Customer's Name and Telephone Number	Amount of Water Purchased (GPD)

MAJOR INDUSTRIAL CUSTOMERS

Customer's Name and Telephone Number	Amount of Water Purchased (GPD)

MAJOR COMMERCIAL CUSTOMERS

Specify whatever contractual conditions may exist between any large water user and the utility, i.e. interrupable service, etc.

____
____
____

22. Has the system experienced any major changes(s) in its water supply source during the past 5 years? ________________________ if so, explain:

____
____
____

Do you anticipate any major change(s) in the system's water supply source during the next 2 to 5 years? ________________________ If so, explain:

____
____
____

23. Have you recently made or do you plan to make any major changes in the system's facilities (treatment plant expansion, extension of the system's service lines, installation of new and/or larger water mains and distribution lines, etc.) during the next 2 to 5 years? ______________
If so, describe these changes and provide the completion date or estimated completion date for all completed and ongoing or anticipated system changes: ____
____
____
____
____
____
____

24. What percent change (increase or decrease) in this system's average monthly water withdrawal, if any, has occurred over the past 5 years?

Explain the reason for this change: ___________________________________
____
____

Do you foresee any significant increase or decrease in the system's average monthly water withdrawal during the next 2 to 5 years and, if so, by what percentage?

Explain the reason for this anticipated change: _______________________
____
____

25. What water supply problems, if any, has this system experienced during the past 5 to 15 years? For example, these problems could include water supply shortages resulting from either inadequate supplies due to low streamflows and groundwater levels or inadequate system pumping and distribution capacity, pump failures,leaking water mains and distribution lines, etc.; water quality problems including taste and odor, excessive iron and manganese concentrations, etc.; turbidity after heavy rainfall and flooding; etc. Describe each problem briefly and indicate its frequency and years(s) of occurrence.

26. Describe the general effects of those water supply shortages and water quality problems, if any, experienced by this system and its users during the 1985-1987 drought on the area's economy, its environment, and the social well-being of its residents.

Economic:

Environment:

Social:

27. Describe the specific measures (public information/education, conservation, use restrictions, rate increase, etc.) utilized by your system to deal with any water supply shortages and quality related problems experienced by your system during the 1985-1986 drought period.

28. Describe the public's response to specific measures used by your system to deal with water supply shortages and quality-related problems, if any, experienced during 1985-1986 drought period. ______________________

29. Describe how and what chemical supply records are maintained for this system. Where are the records located and what records are computerized. Also, what basic information is contained in these records?

30. What chemicals (alum, chlorine, line, etc.) and/or other supplies does your system use in treating its water and what quantity of each is used in a day. Also, how many days supply of each do you normally maintain?

Chemicals/Supplies	Average Daily Use	Normal Supply in days

31. What companies supply these chemicals in your area? Provide names, addresses and telephone numbers of back-up sources as well.

Chemicals	Supplier	Address	Phone

32. Describe how and what equipment supply records are maintained for this system. Where are the records located and what records are computerized. Also, what basic information is contained in the records.

33. Specify the location of all major pieces of equipment and supplies owned by the water system which may be needed to repair the system (including pipes, pumps, hydrants, blowoffs, valves, etc.).

34. List area suppliers of pipe and other major equipment, including portable filters, pumps, and valves.

Items	Supplier	Equipment	Phone

35. Does your system prepare an annual water management and operations report? Yes __________ No __________ Where are these kept? __________

List the names, addresses and phone numbers (or other means of communication) of those individuals who may be able to assist the water system in an emergency. This list should include the plant manager and other current employees, retired personnel, others knowledgeable of water system operations, EPA emergency personnel, Tennessee Office of Water Management Emergency personnel, United States Coast Guard, Tennessee Emergency Management Agency, Food and Drug Administration Poison Control Center, Area Sheriff, Police and Fire Departments, Tennessee Bureau of Investigation, Tennessee Department of Transportation, Chemtrek, Corps of Engineers, Tennessee Valley Authority, and others.

Person	Address	Phone(s)	Means of Communication	Expertize

36. Identify your system's governing body by checking one of the following: Local government__________ Private, reports to local government__________ Private, separate from local government__________ Other (specify) ______

____

____

37. What is the source of your system's operating revenue? ________________

____

____

____

38. What is your system's average cost of water withdrawal? ________________ per ________________

39. Indicate your system's present rate structure by checking one of the following. Uniform __________ Declining block __________ Increasing block __________ Varies by user __________ Other (specify) __________

____

40. Under your system's present rate structure, what is the minimum cost per 1,000 gallons of water for each of the following user groups? Residential __________ Industrial __________ Commercial __________ Other (specify) ____

____

41. What plumbing code, conservation measures and/or other ordinances, if any, are currently in effect in your system's service area?

____

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____

____

42A. Does your system have an active, ongoing public information and education program to inform water users about the relative merits of water conservation and emergency plans in the event of water supply shortages? Yes ____________ No ____________ If yes, describe the program briefly.

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42B. Describe the communication resources available for use in notifying customers and the public of a water shortage or emergency (list newspapers, radio-tv stations, and other means such as automobile public address, etc.):

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43A. Does your system have an active leak detection program? Yes ____________
No ____________

43B. Does your system have a cross-connection program? Yes _______ No _______

44. Identify any alternative sources of water which your system has used in past years to alleviate water supply shortages. For each alternate source identified, indicate the years and amount of water used; the length of time over which the alternative source was utilized; the name, address, and telephone number of the water utility district or owner supplying the water; and any problems encountered in utilizing this source. ____

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45. Identify any alternative sources of water which your system might potentially be able to utilize to alleviate future water supply shortages. For each potential alternate source identified, indicate the type of source and name, address, and telephone number of the water supply district or owner of the water. ______________________________

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46. List, to the extent the data are available, the latest test results and date of the test for each of the following water quality parameters for your system's raw water supply.

Contaminant	Level	Date
Barium	mg/l	
Chloride	mg/l	
Chromium	mg/l	
Copper	mg/l	
Fecal Coliform	mi	
Fluoride	mg/l	
Iron	mg/l	
Lead	mg/l	
Magnesium	mg/l	
Maganese	mg/l	
Methylene Blue Active Substances	mg/l	
Mercury	mg/l	
Nitrate	mg/l	
Selenium	mg/l	
Silver	mg/l	
Sulfate	mg/l	
Total Dissolved Solids	mg/l	
Zinc	mg/l	

47. What percent of your customers use septic fields? ________% Sewer service?______% Other? ______% Please specify what "other" includes.

____

____

48. Average amount of water returned to a public wastewater treatment system in gallons per day. ______________________________

49. Do your sewer and water supply systems have combined billing? Yes ______ No ______

50. Describe and list any contractual arrangements that have been made with other towns, water systems, private supplies, etc. for water, bottled water, water tank truck hauling, pumping equipment, etc. in the event of any emergency. Also, note contact person and phone number(s) where contact can be reached.

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SURVEY FORM FOOTNOTES

1. In completing this inventory, please feel free to call the Tennessee Office of Water Management.

2. Please describe the system's service area in geographic terms including the names of specific communities and/or urban areas, or parts thereof, as well as any rural areas which are served by the system. Also indicate the names of the counties in which the service area lies. Indicate the location of maps showing the areas served, population served, location of treatment and storage facilities, water mains, valves and hydrants, pumping facilities, and large water users, i.e. industries, etc.

3. The location of all supply wells and intakes should be mapped. If the source of supply is a surface water source, also identify the source's intake location by river mile, where possible, or latitude and longitude. Groundwater supplies should be located by latitude and longitude. Specify intake elevation in reservoir.

4. Other suppliers include both private and public water supply systems from which water is purchased either on a regular basis or occasionally for emergency or backup water supply purposes.

5. Water supplies for carrying out public services include water used in fire fighting, street washing, and the maintenance and operation of municipal parks and swimming pools.

6. Water losses in the system include losses due to deteriorating water mains and distribution lines.